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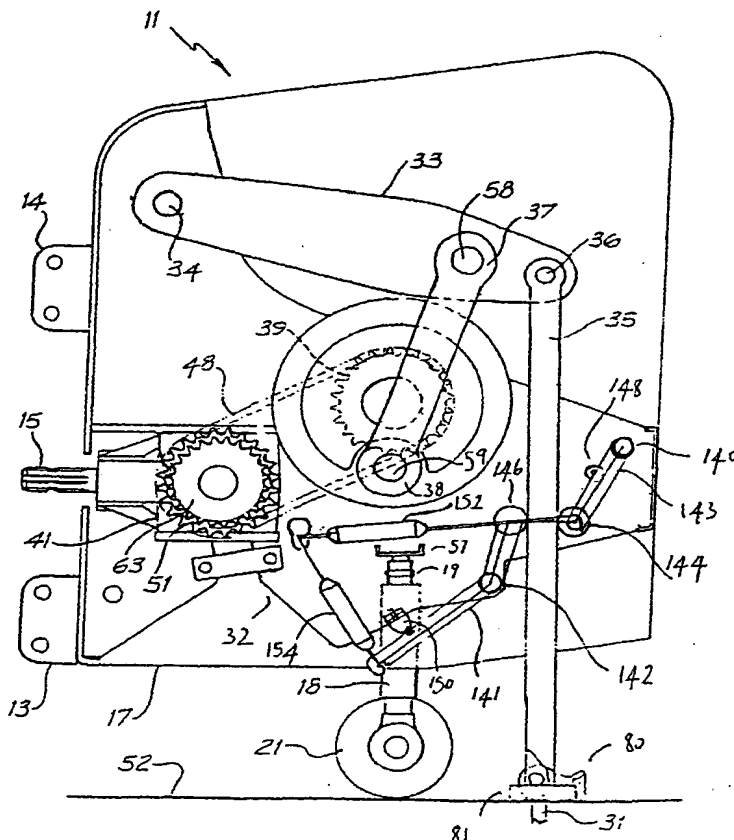
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- (71) Applicant (*for all designated States except US*): **GREEN-CARE PTY LTD** [AU/AU]; 5A/1-3 Endeavour Road, Carlingbah, New South Wales 2229 (AU).
- (72) Inventor; and
- (75) Inventor/Applicant (*for US only*): **LIVINGSTONE, David, John** [AU/AU]; 5A/1-3 Endeavour Road, Carlingbah, New South Wales 2229 (AU).
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(54) Title: **IMPROVED AERATOR MECHANISM**



(57) Abstract: Turf aerator (11) has a reciprocating drive mechanism comprising a tine leg (35) pivotally mounted at an upper end to a drive assembly that reciprocates the tine leg (35). The drive assembly comprises a reciprocating driver member (33) to which the tine leg (35) is pivotally attached at a first point (36) along the drive member (33). The drive member (33) is pivotally connected at a second point (34) to the frame (32) of the aerator (11) and at a third point to a first arrangement comprising of a first roller (144) mounted on a first pivotable arm (143) biased to a forward position. A first stop means (148) mounted to the frame (32) acts to limit travel of the first roller (144) in a forward direction. Also disclosed are a tine leg (35) and a pivotable foot assembly (80) for carrying a tine (31). The assembly (80) includes a base plate (81), a pair of upwardly directed mounting brackets pivotally attached to the tine leg (35). At least one of the mounting brackets includes an extension projecting beyond the horizontal axis. The assembly (80) has an arm to limit pivotal travel of the base plate (81) in a first direction, spring means between the arm and the base plate (80), and a limiting member to limit pivotal travel of the base plate (80) in a second direction.

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Improved aerator mechanism

Introduction

The present invention relates generally to greenkeeping equipment and in particular the invention provides an improved reciprocating drive for a turf
5 aeration device.

Background of the Invention

It is well known that in the cultivation of turf surfaces aeration of the root system is required from time to time to relieve compaction and enable penetration of nutrients beneath the surface mat of the turf. A variety of
10 mechanisms have been used in the past to achieve this end, all of which generally include tines carried in some type of mechanism that allows periodic spiking of the surface. These mechanisms have increased in sophistication over the years from simple tine rollers comprising a drum with a plurality of tines located pointing radially outwardly from its surface to elaborate
15 reciprocating mechanisms.

A basic problem with tine rollers and, which has been overcome to a certain degree by some more advanced systems is that of tearing which occurs when the tine does not enter and exit the turf vertically but instead passes through an arc while it is in the ground. This action damages the turf surface
20 and makes it less useful for its intended purpose during the period immediately following aeration. It is also highly desirable that turf aerators be able to operate quickly in order to minimise the cost of this operation and enable the operation to be performed more regularly. Another cost related factor is the reliability of the equipment which typically decreases with increased speed and
25 is adversely affected by the typically dirty environment in which the equipment must operate, making lubricants applied to bearing surfaces become like grinding pastes which rather than increasing the life of the bearing surface tend to decrease that life rapidly.

In one prior art arrangement an aerator has a plurality of tines located at
30 the ends of tine legs which are reciprocated by a crankshaft and arranged transversely of the aerator. The tine legs are each slidably mounted towards their lower end in a guide which is in turn reciprocated fore and aft to keep the tine leg vertical while it is in engagement with the ground. The prior art tine legs are articulated to accommodate the differing relative horizontal speeds of
35 the crankshaft and the leg guides, which maintain the lower portion of the legs in vertical orientation. Typically when an aerator is required to penetrate the

ground at 50mm spacings, the machine can only move forward 50mm for every revolution of the crank shaft and therefore a relatively high tine speed is required for reasonable rate of coverage. Due to their mechanical arrangement, prior art machines were subject to higher rates of wear and fixed
5 hole arrangements limited by a single cam.

The reciprocating drive mechanism of the present invention is designed to ameliorate or overcome some or all of these deficiencies in prior art equipment.

Summary of the Invention

10 According to a first aspect, the present invention consists in a turf aerator with a reciprocating drive mechanism comprising:

a substantially rigid tine leg pivotally mounted at an upper end to a drive assembly arranged to reciprocate the tine leg along its longitudinal axis,
the drive assembly comprising:

15 a reciprocating drive member to which the tine leg is pivotally attached at a first point along the drive member, the drive member being pivotally connected at a second point to a frame and at a third point to a first eccentric, the first eccentric being rotated to reciprocate the first point on the drive member substantially vertically; and

20 a guide arrangement comprising:

a first roller mounted on a first pivotable arm, located rearward of the tine leg relative to the normal direction of travel of the aerator and biased to a forward position; and

25 a first stop means mounted to the frame, the first stop means acting to limit travel of the first roller in a forward direction.

The third point is preferably located intermediate the first and second points. However, it will be appreciated that the third point need not be located intermediate the first and second points. The lower end of the tine leg is able to move in a rearward direction to allow the tine to move relative to the machine
30 while the tine is in the ground. The tine leg is biased to a forward position such that when the tine leaves the ground, the tine leg returns toward the forward end of its travel ready for re-engagement with the ground. Biasing may be by a variety of spring arrangements. By acting on a variable point on the tine leg the roller exerts a variable return torque in the forward direction, the torque
35 increasing to a maximum as the tine leg reaches the top of its stroke.

The first stop means may be mounted on the rearward side of the tine leg, the first stop means acting to abut the first pivotable arm to limit movement of the first roller in the forward direction. A second roller may be mounted on a second pivotable arm located forward of the tine leg relative to the normal direction of travel of the aerator and biased to a rearward position. A second stop means may be mounted to the frame. The second stop means may act to limit travel of the second roller in the rearward direction. In this embodiment, the first and second rollers may engage a lower portion of the tine leg whereby the first roller biases the tine leg towards a position ready for insertion of the tine into the ground and the second roller dampens overtravel of the tine leg in the forward direction.

The drive member may be pivotally connected at a second point to a second eccentric. The first and second eccentrics may be rotated in synchronism to reciprocate the first point on the drive member both vertically and horizontally. In this embodiment, the diameter of the path of rotation of the second eccentric is less than the path of rotation of the first eccentric, and the two eccentrics preferably rotate in the same direction, more preferably in a counter-clockwise rotation.

In various embodiments, the timing of the eccentrics relative to one another may be varied in order to adjust the operation of the tine leg and in particular, the timing may be adjusted in a given embodiment depending upon the conditions in which the aerator is operating.

In a third, preferred embodiment, the biasing may be effected by way of a resiliently flexibly mounted guide arrangement. The guide arrangement may comprise a pair of rollers. One roller may be mounted on each side of the tine leg. Each roller may be rotatably mounted at the end of a roller arm. A plurality of coil springs may be connected to the roller and/or its arm for drawing the roller into abutment with the tine leg and for exerting a restoring force on the tine leg.

This guide arrangement may also serve to damp rapid horizontal reciprocatory motion of the tine leg when the aerator is rapidly traversing a surface, in use.

According to a second aspect the present invention consists of a tine leg and pivotable foot assembly for carrying a tine, wherein the assembly comprises:

a base plate;

a pair of upwardly directed mounting brackets extending either side of the tine leg and pivotably attached thereto about a transverse horizontal axis and at least one of the mounting brackets including an extension projecting beyond the horizontal axis;

- 5 an arm extending from the tine leg substantially perpendicular to the leg to limit pivotal travel of the base plate at an extremity of travel in a first direction;

spring means between the arm and the base plate or an extension of the base plate to bias the base plate towards the extremity of travel in the first
10 direction; and

a limiting member extending from the tine leg in a path of the extension projecting from the at least one of the mounting brackets to limit pivotal travel of the base plate at an extremity of travel in a second direction.

Preferably a first stop means such as a resilient rubber pad is located
15 between the extension of the at least one mounting bracket and the second travel limiting bracket. Preferably also a second stop means, which may also be a resilient rubber pad, is located between the limiting member and the base plate. Optionally a locking member may be included to lock the base plate against movement relative to the tine leg in certain applications. The locking
20 member may be a wedge inserted between the extension of the at least one mounting bracket and the limiting member.

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not
25 the exclusion of any other element, integer or step, or group of elements, integers or steps.

Brief Description of the Drawings

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

- 30 Figure 1 illustrates a perspective view of a first embodiment of the invention comprising an aerator arranged to be carried by, or towed behind a vehicle provided with a three point hitch;

Figure 2 is a side elevation of the aerator mechanism at its lowest point in a cycle of operation;

- 35 Figure 3 illustrates a perspective view of a second embodiment of the invention comprising a self-propelled turf aerator;

Figure 4 illustrates a perspective view of a "ride on" embodiment of the invention;

Figure 5 illustrates a side elevation of a second embodiment of the aerator mechanism at its highest point in its cycle of operation;

5 Figure 6 is a side elevation of the aerator mechanism of Figure 5 showing paths of various components during a cycle of operations;

Figure 7 illustrates a side view of the guide mechanism as shown in Figures 2, 5 and 6; and

10 Figure 8 illustrates a side elevation of the foot mechanism as shown in Figures 2 and 5.

Detailed Description of the Preferred Embodiments

Referring to Figure 1, a first implementation of the invention is illustrated in which an aerator 11 of the type towed behind a tractor or similar vehicle is shown. In this embodiment, mounting points 12, 13, 14 are provided for
15 attachment to the three-point hitch of the towing vehicle and an input shaft 15 is arranged to connect to a power take-off of the towing vehicle. The aerator mechanism 16 is mounted on a chassis 17 and the rear wheels 21 (see Figure 2) are mounted on a ram 18, extending below a bracket 57 on the chassis 17 and connected by resilient connection 19, such that when the towing vehicle
20 raises the three point hitch, the chassis 17 raises but the wheels or a roller 21 connected to the ram 18 may be lowered to remain in contact with the ground to help support the aerator.

Referring to Figure 2, an embodiment of the invention is illustrated wherein the aerator mechanism is shown in detail at a point of its cycle where
25 the aerator tines 31 are fully lowered into the turf surface 52. The mechanism is mounted on a frame 32 extending above the chassis 17 and includes a substantially horizontally extending reciprocating drive member 33 mounted to the frame 32 by a pivotal connection 34, and a substantially vertical tine leg 35 connected at its upper end to the opposite end of the drive member 33 by a
30 pivotal connection 36. The tines 31 are mounted to a platform that forms part of the foot assembly 80 which is mounted to the lower end of the tine leg 35. A push rod 37 extends between a pivotable connection 58 on the drive member 33 and the pivotable connection 59 on a crank 38 to drive the drive member 33 and thereby the tine leg 35 in reciprocating motion. The crank 38 is connected
35 to a coaxial chain wheel 39 which is driven via chains 48, chain wheel 51 and

gearbox 41 and power take-off connection 15. An adjustable tensioning means may be provided (not shown) to regulate the movement of the chains 48.

Rotation of the crank 38 causes reciprocation of the drive member 33 via the push rod 37 and subsequently this causes the tine leg 35 to reciprocate
5 substantially vertically. Reciprocation is controlled in synchronisation with forward motion of the aerator such that a uniform pattern of holes is punched in the turf surface 52 as the aerator advances. As the aerator mechanism moves forward with the tines 31 inserted in the ground, the tines moves backward relative to the implement.

10 After the tines 31 are retracted from the ground, the tine leg 35 is moved forward by a first guide mechanism comprising a first roller 144 carried on a first arm 143 mounted to the frame at a first pivot point 140 and biased to a forward position by a first spring 152. However, the first guide mechanism is located behind the tine leg 35, and acts to push the tine leg 35 forward when it
15 leaves the ground 52 and to continuously and smoothly push it towards the forward extremity of its travel. A first stop means mounted to the frame 32 acts to abut the first pivot arm 143 when the first roller 144 reaches a forward most position. The first roller 144 pushes the tine leg 35 forward until the tine leg 35 re-enters the ground, however if overtravel occurs the tine leg 35 will strike the
20 second guide mechanism, which decelerates the lower end of the tine leg 35 prior to the tines 31 being reinserted into the turf surface 52.

The second guide mechanism includes a second arm 141 with a second pivot point 142 which is mounted to the frame 32. At a first end of the second arm 141 is attached a spring 154 mounted to the frame 32 (or a bracket or
25 member extending from the frame). At a second end of the second arm 141 is attached a second roller 146 which abuts the tine leg 35 at least when it approaches its forwardmost position. A second stop means 150 mounted to the frame 32 abuts the second arm 141 when the second roller reaches a most rearward position. The second stop means includes a resilient buffer to
30 cushion the impact of the second arm 141. In some embodiments, the second roller 146 may remain in contact with the tine leg 35 at substantially all times.

Because the guide mechanisms, and in particular the first guide mechanism, operate at variable points on the tine leg, depending upon the point of the operating cycle, the torque applied to move the leg forward as it is
35 removed from the ground increases towards maximum at the top of its stroke. This results in a smooth increase in acceleration as the tine is lifted.

Any torque applied by the second guide mechanism is similarly reduced as the tine leg descends.

When the aerator 11 is set at its normal operating height, the wheels or roller 21 will be in contact with the ground 52 to help support the aerator (or in self-propelled models, to substantially fully support the aerator). When aeration is not in progress, the jack 18 is extended to raise the chassis 17 sufficiently to lift all of the tines clear of the ground, regardless of their position in the aeration cycle. In the case of the tractor-mounted model of Figures 1 & 2, this would be carried out in conjunction with the raising of the 3-point hitch, connected to the mounting points 12, 13 14. The jack 18, additionally serves as a tine depth adjustment mechanism.

It should be noted that while one tine leg 35 is illustrated for the sake of simplicity, typically 2, 4, or more tine legs and their associated drive mechanisms as described above, will be provided side by side in the chassis 17. These mechanisms are operated at the same speed (they are driven off one gearbox), but will typically have their operating cycles offset such that the load on the drive components is distributed over the cycle and not subjected to the shock of all tines hitting the ground and being driven in simultaneously. This also reduces the lifting force created as the tines are driven into hard earth.

In a further embodiment, the first guide mechanism and second guide mechanism may be replaced with a first rosta tensioner arranged rearwardly of the tine leg 35, and a second rosta tensioner arranged ahead of the tine leg 35. The first rosta tensioner includes a first torsion block, a first tensioner arm extending from the torsion block and a first roller which abuts the tine leg 35 substantially all of the time. The second rosta tensioner includes a second torsion block, a second tensioner arm extending from the torsion block and a second roller which preferably abuts the tine leg 35 when it approaches the forwardmost position. Each torsion block is preferably formed of a resilient material and is preferably mounted at one end to the frame 32.

Turning to Figure 3, a self propelled, "walk-behind" version of the aerator is illustrated. In this embodiment, again the aerator mechanism 16 is mounted on a chassis 17 and ram 18 resiliently connected to the chassis carries the wheels on a roller 21. In this embodiment, the front of the implement is supported on a single or double wheel 23 mounted at the lower end of a post 24 rotatably mounted through the forward end of the chassis 17.

A control arm 25 extends from and is pivotally connected to the upper end of the post 24 and includes a plurality of control levers 26 used to operate the implement. A motor 27 is provided to drive the aerator mechanism and to propel the implement via the rear wheels 21.

- 5 In this embodiment, the reciprocating drive member 33 is connected to a rotating eccentric 57 at one end by a pivotal connection 34, and a substantially vertical tine leg 35 connected at its upper end to the opposite end of the drive member 33 by a pivotal connection 36. The eccentric 57 is connected to a belt wheel 44, chain 45, chain wheel 63 and gearbox 41. The eccentric also
10 includes a counter balance 47 to minimise vibration caused by the horizontal reciprocation of the drive member 33.

Referring to Figure 4, a "ride on" version of the aerator is illustrated, in which the forward end of the chassis 17 is elongated and an operator's seat 71 is provided behind the operating arm 25.

- 15 To avoid problems caused by lubricating oil, all of the pivot points and drive shaft bearings in the mechanisms are manufactured with self lubricating bushes formed of lubrication impregnated nylon and sealed bearings are used wherever required.

- Referring to Figure 5, a further embodiment of the invention is illustrated
20 wherein the aerator mechanism is again shown in detail at a point of its cycle where the aerator tines 31 are raised above the turf surface 52. In this embodiment, the jack 18 is extended to raise the chassis 17 sufficiently to lift all of the tines clear of the ground.

- The mechanism is mounted on a frame 32 extending above the chassis
25 17 and includes a substantially horizontally extending reciprocating drive member 33 connected to a rotating eccentric 57 at one end by a pivotal connection 34, and a substantially vertical tine leg 35 connected at its upper end to the opposite end of the drive member 33 by a pivotal connection 36. A push rod 37 extends between a pivotable connection 58 on the drive member
30 33 and the pivotable connection 59 on a crank 38 to drive the drive member 33 and thereby the tine leg 35 in reciprocating motion. The crank 38 is connected to a coaxial chain wheel 39 which is driven via chains 48, chain wheel 51 and gearbox 41 and power take-off connection 15 and the eccentric 57 is similarly connected to a coaxial chain wheel 44, chain 45, chain wheel 63 and the
35 gearbox 41. The eccentric 57 also includes a counter balance 47 to minimise vibration caused by the horizontal reciprocation of the drive member 33.

Rotation of the crank 38 causes reciprocation of the driver member 33 via the push rod 37 and subsequently this causes the tine leg to reciprocate substantially vertically. Horizontal reciprocation of the end of the drive member 33 having the connection 36 is effectively damped by the rotation of the eccentric 57 so that a vertical throw of said end of the drive member 33 is much greater than a horizontal throw of said end. Reciprocation is controlled in synchronisation with forward motion of the aerator such that a uniform pattern of holes is punched in the turf surface 52 as the aerator advances. As the implement moves forward with the tines 31 inserted in the ground, the tines move backward relative to the implement.

A tine 31 is mounted on a platform 81. To an upper surface of the platform 81 is mounted a spring 84. The platform 81 is pivotally mounted via a pin 82 to a bottom of the tine leg 35. An arm 92 is connected perpendicularly to the tine leg 35. A top of the spring 84 is connected to the arm. It will be appreciated that the invention is not limited to the application whereby a substantially vertical tine leg is pivotally connected 36 to the drive member 33. A substantially vertical tine leg may be rigidly fixed to the drive member 33.

Referring to Figure 6, the mechanism of Figure 5 is depicted (with some parts removed) and path tracings for some points in the mechanism superimposed. It will be noted that in operation, as described here, the chain wheel 44 and the chain wheel 39 rotate in the same direction. However, it is also possible to have these wheels counter rotate and/or to alter their timing relative to one another, to vary the hole pattern, or tine penetration and exit characteristics. However, in the present embodiment, the chain wheels are timed to operate in complete synchronism with both reaching bottom dead centre at the same time.

Under these circumstances, the pivot point 36 at the top of the tine leg follows the path 136 during one cycle of operation, and a point near the lower end of the tine leg will follow the path 135 assuming no ground engagement.

Figure 7 illustrates the guide arrangement 139 as shown in Figures 2, 5 and 6. The guide arrangement is provided for guiding the lower end of the tine leg 35 and to ensure the required insertion into, and retraction from, the surface 52 of the tine. The guide arrangement comprises a first guide mechanism and a second guide mechanism. The first guide mechanism includes a first arm 143, at the first end of which is a first pivot 140 which is mounted to the frame 32. At a second end of the first arm 143 is a first roller 144, which abuts the

tine leg 35. Attached to the first roller 144 is a first tension spring 152. A first stop means 148 mounted to the frame 32 abuts the first arm 143 when the first roller 144 reaches a most forward position. The stop means includes a resilient buffer to cushion the impact of the tine leg.

5 Similarly, the second guide mechanism includes a second arm 141 with a second pivot point 142 which is mounted to the frame 32. At a first end of the second arm 141 is attached a tension spring 154 mounted to the frame 32. At a second end of the second arm 141 is attached a second roller 146 which abuts the tine leg 35. A second stop means 150 mounted to the frame 32
10 abuts the second arm 141 to limit travel of the second roller 146 in the rearward direction. A force exerted perpendicularly away from the lower end of the second arm 141 by the spring 154 will result in a clockwise rotation about the pivot point 142. The clockwise rotation about the pivot point 142 will exert a rearward force on the tine leg 35 when the tine leg comes into contact with the
15 second roller 146.

By adjusting the gearing in the gearbox of the aerator, the ground spacing of holes created by the tines 31 can be varied. For very rapid traversal of the turf 52, chatter of the tine legs 35 is inhibited by means of the spring-biased rollers 142 and 144. The tine legs 35 are also constrained against
20 lateral movement by means of a lined bracket 112 through which the tine leg 35 passes. The bracket 112 is slotted with a plastics lining 114 which is also self lubricating. For example, the lining 114 maybe PTFE.

Figures 8A and 8B illustrate the foot assembly 80 as shown in Figure 2. The foot assembly 80 is mounted to the tine leg 35.

25 Referring to Figure 8A, the foot assembly 80, includes a first mounting member 87, and a second mounting member (not shown) which extend from a platform 81 and a tine leg 35 is pivotably connected between the first mounting member and the second mounting member. Each tine leg is connected to the mounting member by a pin 82.

30 An arm 92 extends from the tine leg 35. Stopper 89 is mounted on the arm 92 and rests against the platform 81 when the platform 81 is at a first end of its pivotal travel.

A spring 84 is mounted on the platform 81 behind (in the direction of movement of the aerator 11) the tine leg 35. The spring 84 is connected to an
35 extremity of the arm 92.

Figure 8B illustrates the foot assembly 80 when the spring 84 is extended. Second stoppers 88 are attached to a lip 87a of each mounting member. Angle brackets 93 are mounted on the tine leg 35. Second stoppers 88 stop against the angle brackets 93 when the tine leg 35 is at a second end
5 of its pivotal travel.

The pivoting foot assembly 80 of Figures 8A and 8B which carries the tine 31, is intended to rotate while the tine is in the ground allowing the tine to remain substantially vertical while the tine leg 35 swings through an arc. The foot pivots back to its original position under influence of the spring 84 when the
10 tine leaves the ground.

Under some circumstances, it is desirable to restrict movement of the foot assembly 80 relative to the tine leg 35 such that the tine 31 pivots in the ground. To achieve this an optional wedge shaped block 94 may be clamped between the tine leg 35 and the angle bracket 93 to hold the foot assembly 80
15 at one end of its travel relative to the tine leg 35.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be
20 considered in all respects as illustrative and not restrictive.

CLAIMS:

1. A turf aerator with a reciprocating drive mechanism comprising:
a substantially rigid tine leg pivotally mounted at an upper end to a drive
assembly arranged to reciprocate the tine leg along its longitudinal axis,
5 the drive assembly comprising:
a reciprocating drive member to which the tine leg is pivotally
attached at a first point along the drive member, the drive member being
pivotally connected at a second point to a frame and at a third point to a first
eccentric, the first eccentric being rotated to reciprocate the first point on the
10 drive member substantially vertically; and
a guide arrangement comprising:
a first roller mounted on a first pivotable arm, located rearward of
the tine leg relative to the normal direction of travel of the aerator and biased to
a forward position; and
15 a first stop means mounted to the frame, the first stop means acting
to limit travel of the first roller in a forward direction.
2. The turf aerator of claim 1, wherein the third point is located intermediate
the first and second points.
3. The turf aerator of claim 1 or 2, wherein the lower end of the tine leg is
20 free to move in a rearward direction relative to the machine while the tine is in
the ground and the machine is moving forward, and the tine leg is biased to a
forward position by biasing means acting on the first pivotable arm, such that
when the tine leaves the ground, the tine leg returns toward the forward end of
its travel ready for re-engagement with the ground.
- 25 4. The turf aerator of claim 3, wherein the biasing means comprises a
spring means.
5. The turf aerator of claim 4, wherein the roller acts on a variable point on
the tine leg to exert a variable return torque in the forward direction, the torque
increasing to a maximum as the tine leg reaches the top of its stroke.
- 30 6. The turf aerator as claimed in any one of claims 1-5, wherein, the first
stop means is mounted on the rearward side of the tine leg, the first stop
means acting to abut the first pivotable arm to limit movement of the first roller
in the forward direction.
7. The turf aerator as claimed in any one of claims 1-6, wherein a second
35 roller is mounted on a second pivotable arm located forward of the tine leg
relative to the normal direction of travel of the aerator and biased to a rearward

position, the second roller being located to abut the tine leg in a forward part of its motion.

8. The turf aerator of claim 7, wherein a second stop means is mounted to the frame and located to limit travel of the second roller in the rearward
5 direction.

9. The turf aerator of claim 8, wherein the first and second rollers engage a lower portion of the tine leg, whereby the first roller biases the tine leg towards a position ready for insertion of the tine into the ground and the second roller dampens overtravel of the tine leg in the forward direction.

10 10. The turf aerator as claimed in any one of claims 1-9, wherein the drive member is pivotally connected at a second point to a second eccentric.

11. The turf aerator of claim 10, wherein the first and second eccentrics are rotated in synchronism to reciprocate the first point on the drive member both vertically and horizontally.

15 12. The turf aerator of claim 11, wherein the diameter of the path of rotation of the second eccentric is less than the diameter of the path of rotation of the first eccentric.

13. The turf aerator of claim 12, wherein the two eccentrics rotate in the same direction.

20 14 The turf aerator of claim 13, wherein the two eccentrics rotate in a counter-clockwise rotation when viewed from the left side of the direction of travel.

15. The turf aerator as claimed in any one of claims 1-14, wherein the timing of the eccentrics relative to one another is variable in order to permit
25 adjustment of the operation of the tine leg.

16. The turf aerator as claimed in any one of claims 1-15, wherein the biasing is effected by way of a resiliently, flexibly mounted, guide arrangement, comprising a pair of rollers, each of which is mounted on opposite sides of the tine leg, each roller being rotatably mounted at the end of a roller arm and, a
30 plurality of coil springs being connected to the roller and/or its arm for drawing the roller into abutment with the tine leg and for exerting a restoring force on the tine leg.

17. The turf aerator of claim 16, wherein the pair of rollers serve to damp rapid horizontal reciprocatory motion of the tine leg when the aerator is rapidly
35 traversing a surface, in use.

18. A tine leg and pivotable foot assembly for carrying a tine, wherein the assembly comprises:

a base plate;

a pair of upwardly directed mounting brackets extending either side of
5 the tine leg and pivotably attached thereto about a transverse horizontal axis
and at least one of the mounting brackets including an extension projecting
beyond the horizontal axis;

an arm extending from the tine leg substantially perpendicular to the leg
to limit pivotal travel of the base plate at an extremity of travel in a first
10 direction;

spring means between the arm and the base plate or an extension of the
base plate to bias the base plate towards the extremity of travel in the first
direction; and

a limiting member extending from the tine leg in a path of the extension
15 projecting from the at least one of the mounting brackets to limit pivotal travel of
the base plate at an extremity of travel in a second direction.

19. The tine leg of claim 18, wherein a first stop means is located between
the extension of the at least one mounting bracket and the second travel
limiting bracket.

20. The tine leg of claim 19, wherein the first stop means is a resilient rubber
pad.

21. The tine leg of claim 19 or 20, wherein a second stop means is located
between the limiting member and the base plate.

22. The tine leg of claim 21, wherein the second stop means is a resilient
25 rubber pad.

23. The tine leg of claim 18, 19, 20, 21 or 22, wherein a locking member is
provided to releasably lock the base plate against movement relative to the tine
leg.

24. The tine leg of claim 23, wherein the locking member is a wedge inserted
30 between the extension of the at least one mounting bracket and the limiting
member.

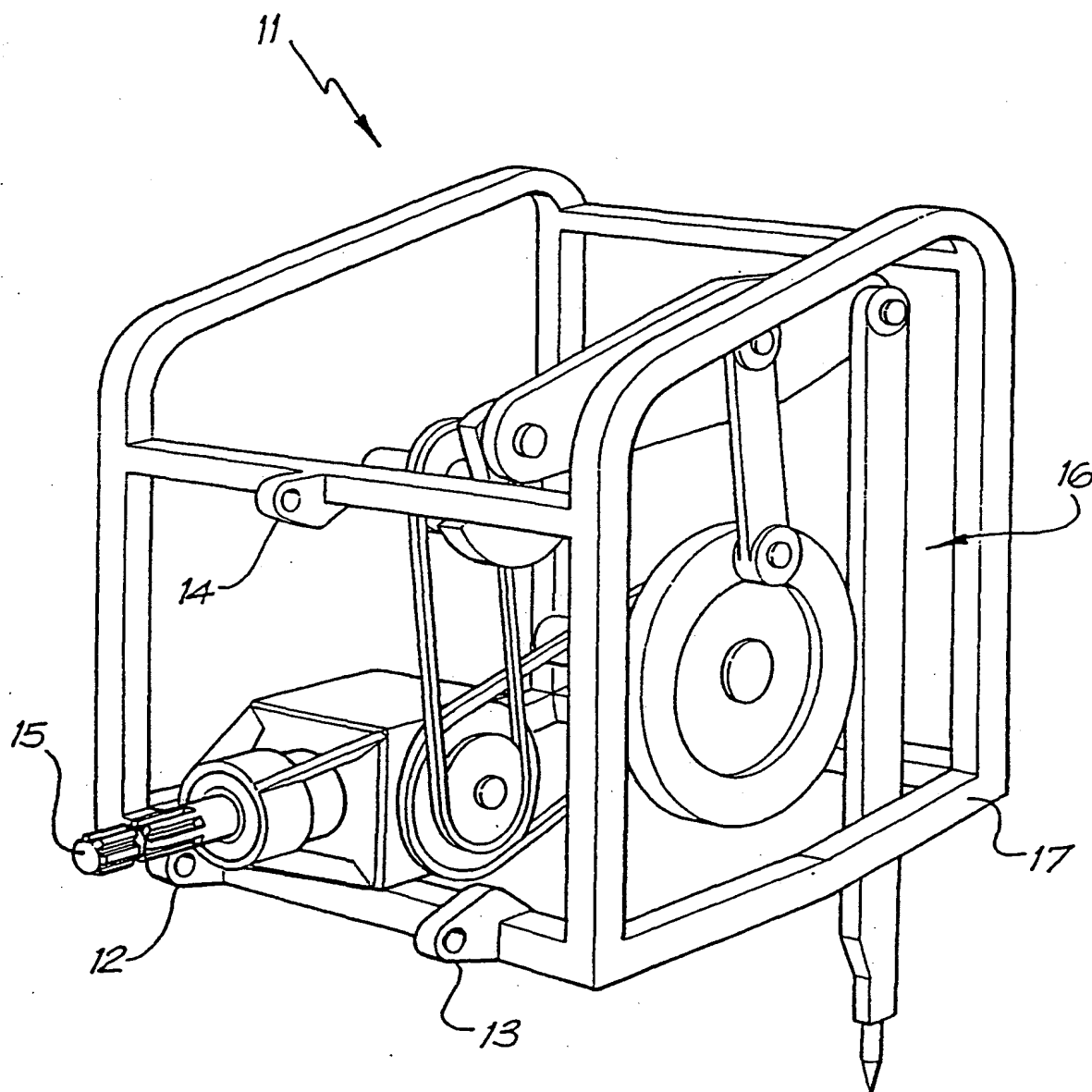


FIG. 1

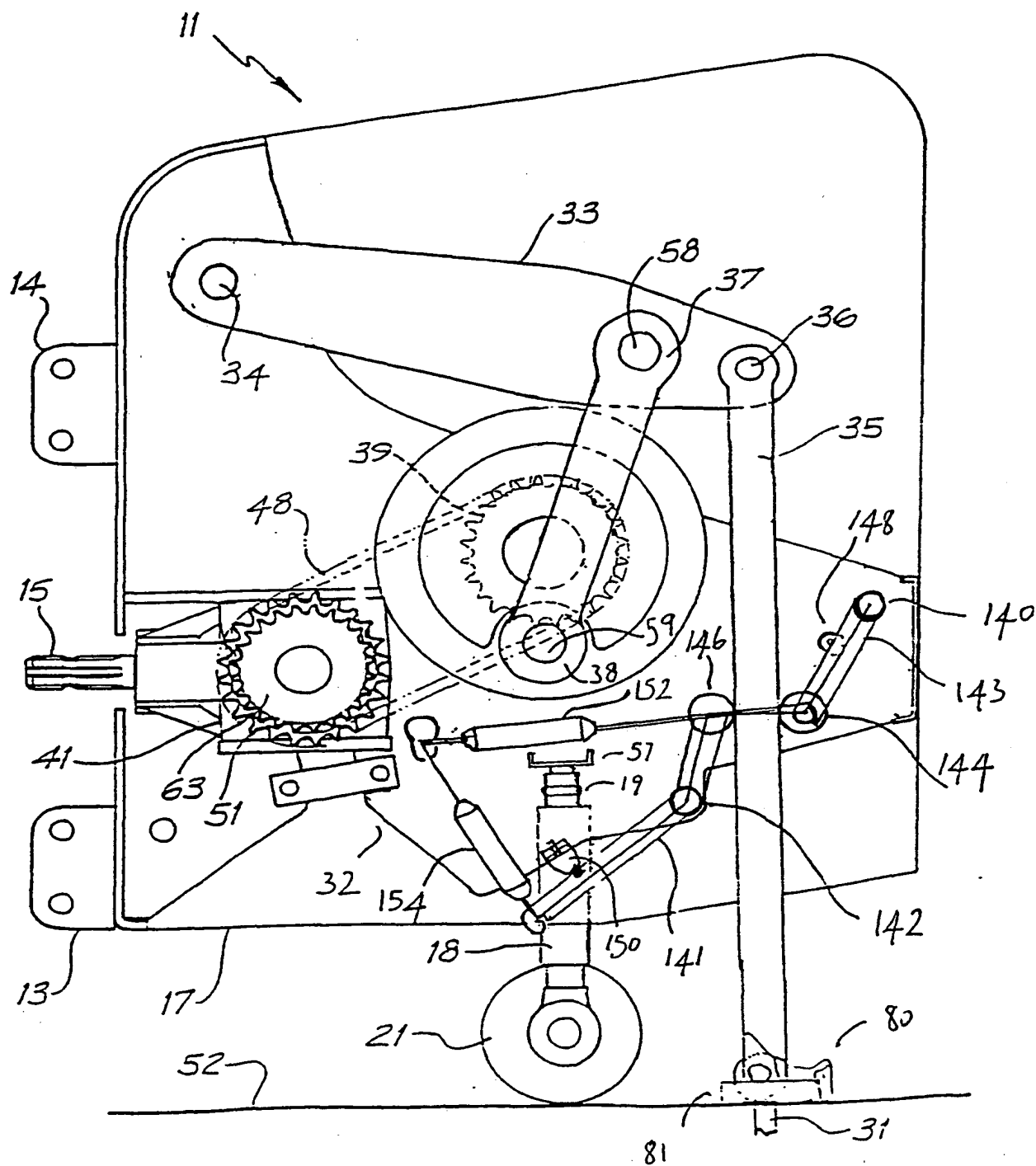


FIG. 2

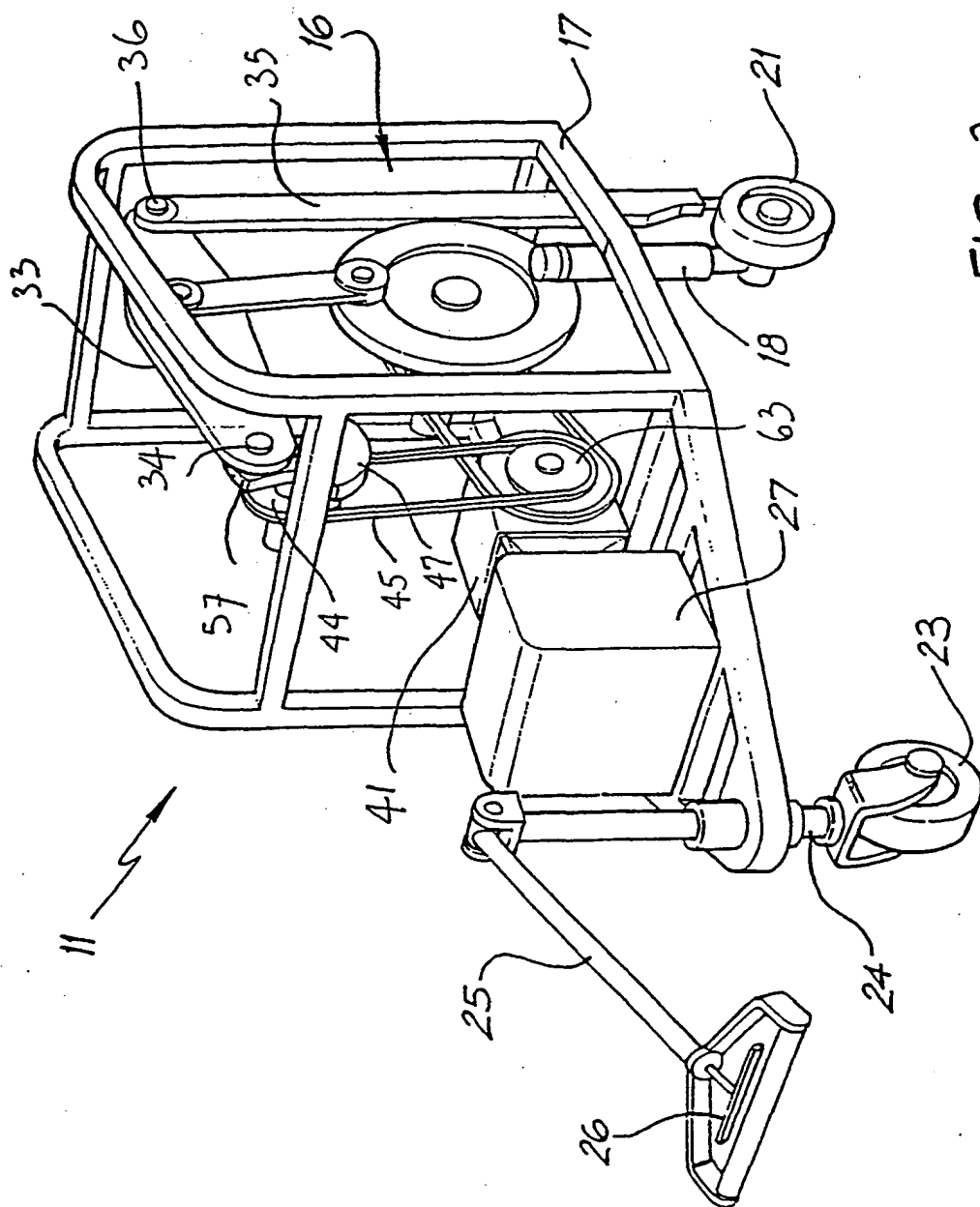


FIG. 3

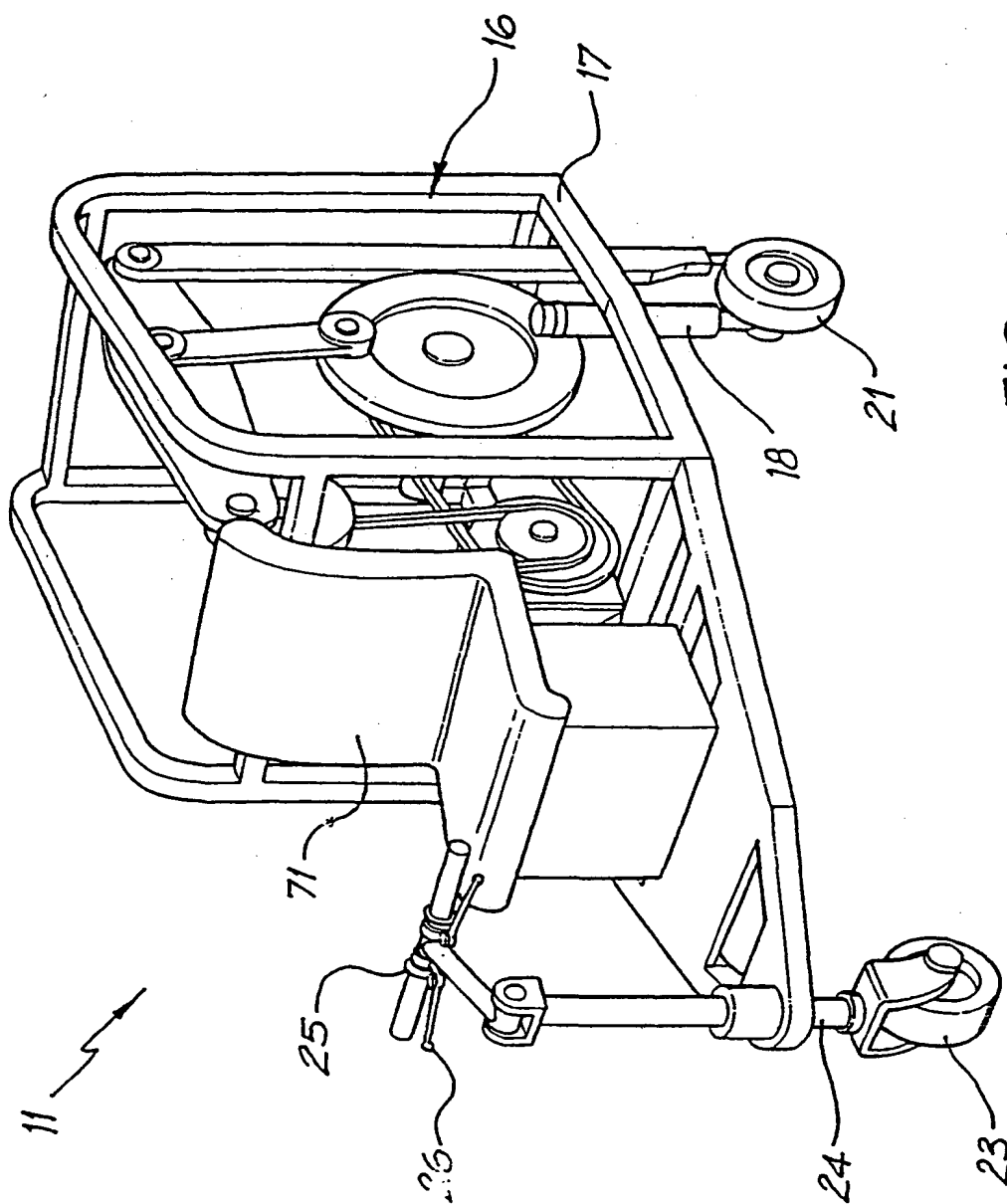


FIG. 4

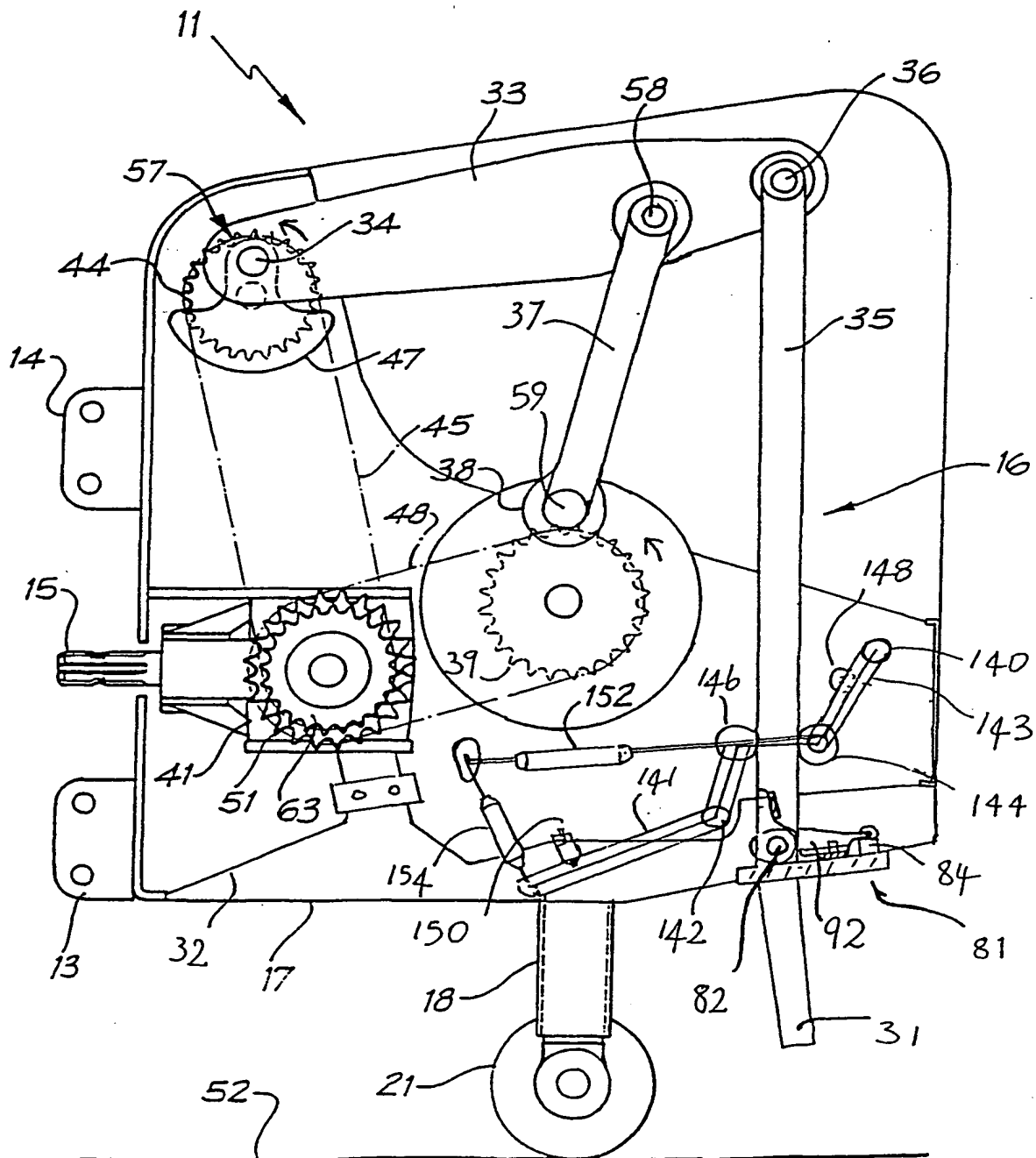


FIG. 5

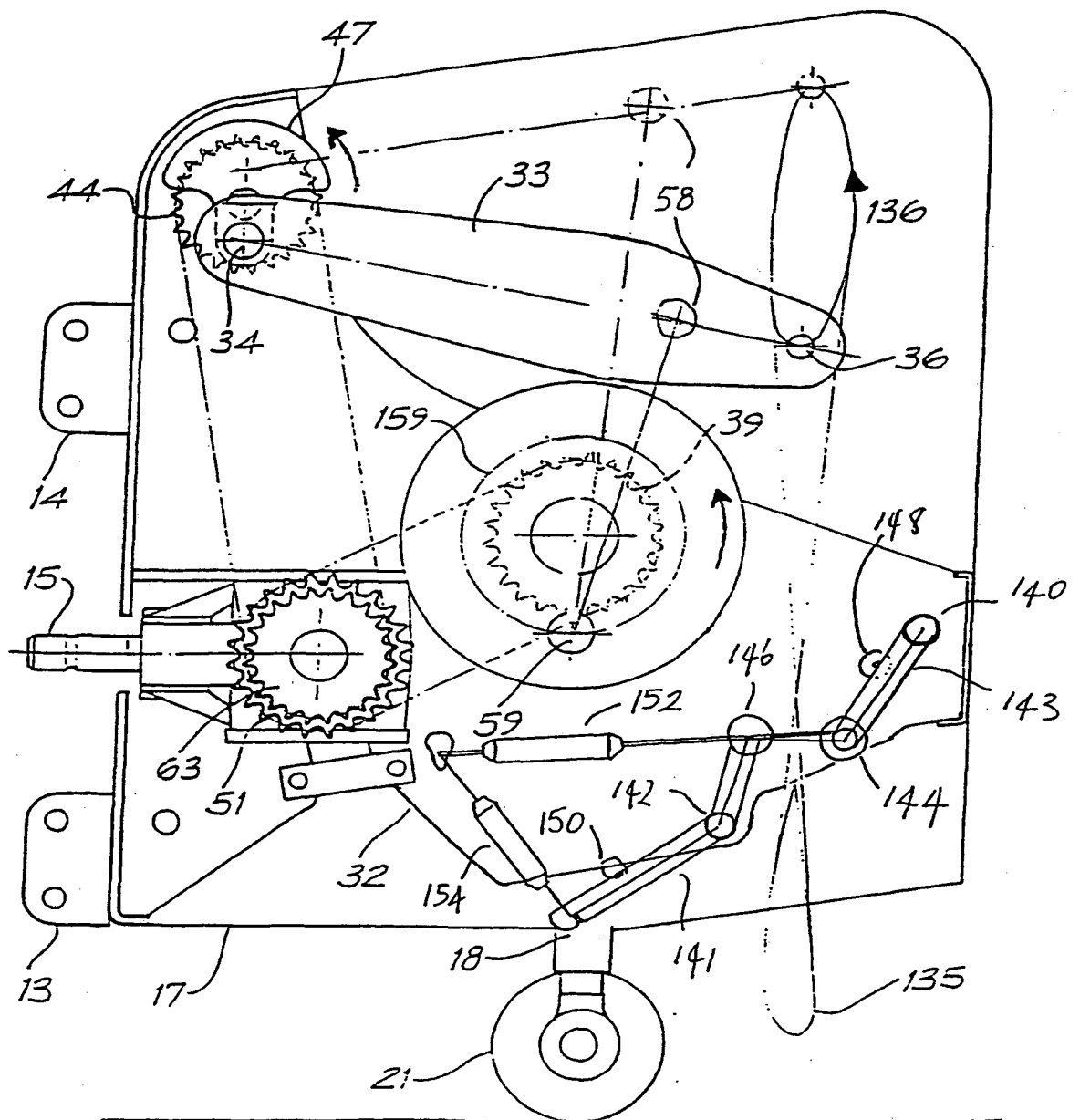


FIG. 6

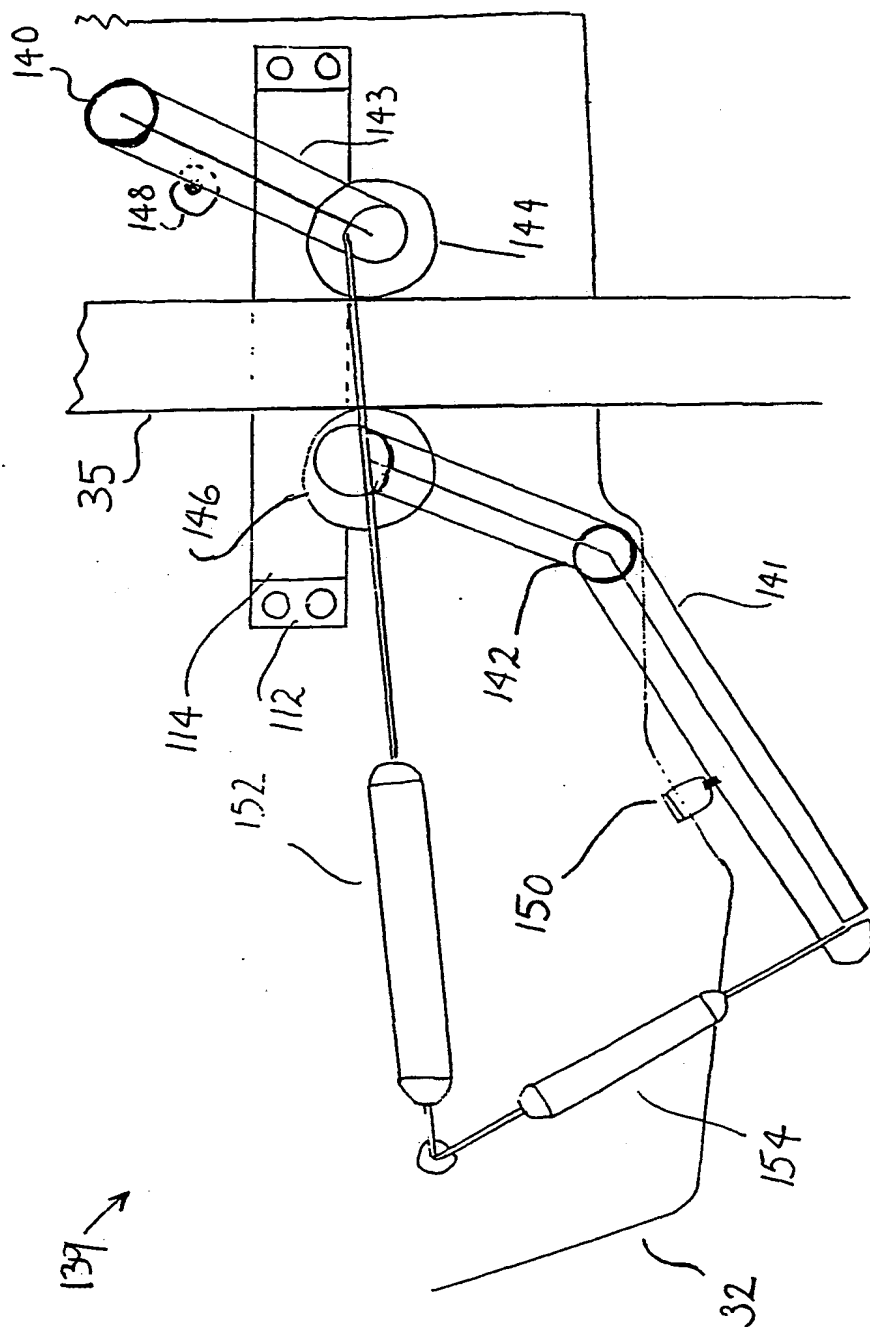
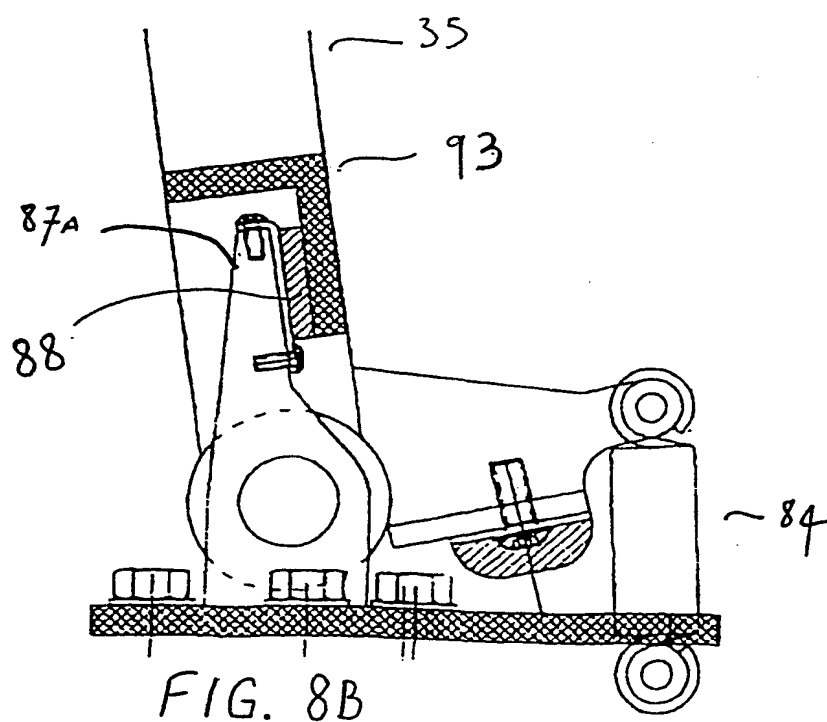
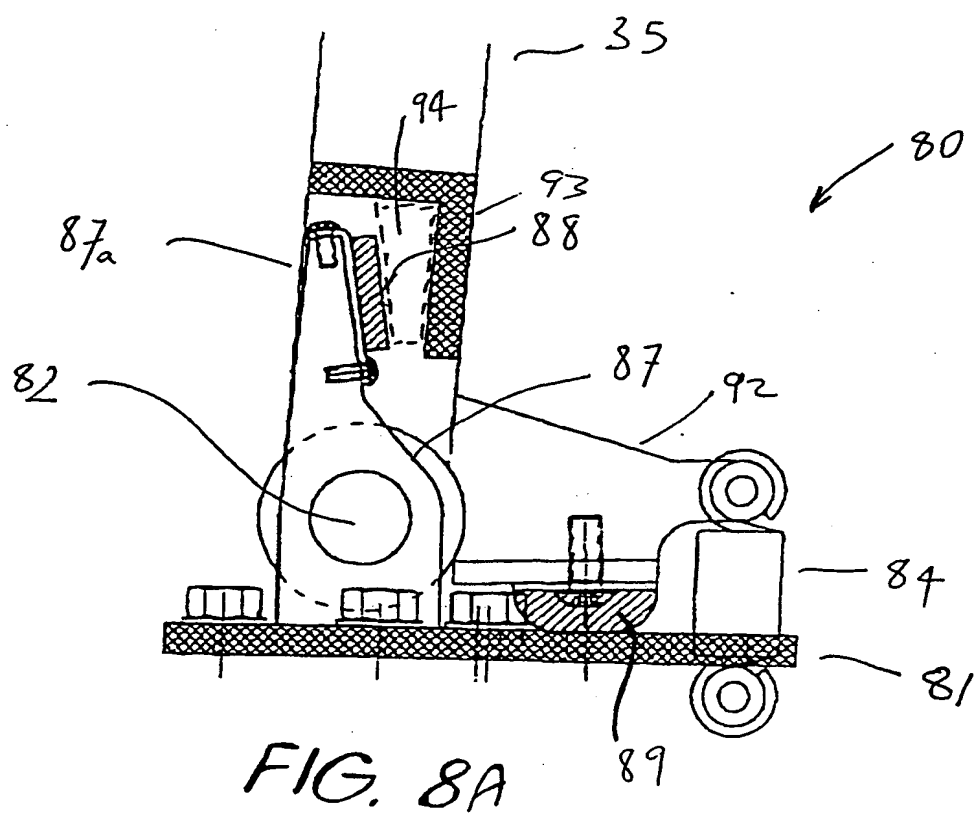


FIG. 7



INTERNATIONAL SEARCH REPORT

 International application No.
PCT/AU02/00620

A. CLASSIFICATION OF SUBJECT MATTER					
Int. Cl. ⁷ : A01B 45/02					
According to International Patent Classification (IPC) or to both national classification and IPC					
B. FIELDS SEARCHED					
Minimum documentation searched (classification system followed by classification symbols)					
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched					
AU: IPC A01B 45/02					
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)					
DWPI: IPC A01B 45/02					
C. DOCUMENTS CONSIDERED TO BE RELEVANT					
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.			
P, X	WO 01/47341 A (GREENCARE PTY LTD) 5 July 2001 Page 4 line 15 to page 6 line 26, claims 7 & 10 and figures 2, 3	1-17			
A	US 4400984 A (RONBECK) 30 August 1983 Whole document	1-17			
A	GB 2318268 A (SISIS EQUIPMENT LIMITED) 22 April 1998 Whole document	18-24			
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex					
* Special categories of cited documents: <table style="width: 100%; border: none;"> <tr> <td style="width: 33%; vertical-align: top;"> "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td style="width: 33%; vertical-align: top;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family </td> <td style="width: 33%;"></td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family				
Date of the actual completion of the international search 11 June 2002		Date of mailing of the international search report 19 JUN 2002			
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929		Authorized officer LIONEL BOPAGE Telephone No : (02) 6283 2153			

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU02/00620

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-17 and
2. Claims 18-24

as reasoned on the extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU02/00620**Supplemental Box**

(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1 to 17 are directed to a turf aerator with a reciprocating drive mechanism comprising a tine leg pivotally mounted at an upper end to a drive assembly that reciprocates the tine leg. The drive assembly comprises a reciprocating drive member to which the tine leg is pivotally attached at a first point along the drive member. The drive member is pivotally connected at a second point to the frame of the aerator and at a third point to a first eccentric. Rotating first eccentric reciprocates the first point substantially vertically. A guide arrangement comprises of a first roller mounted on a first pivotable arm biased to a forward position. A first stop means mounted to the frame acts to limit travel of the first roller in a forward direction. It is considered that the turf aerator as claimed comprises a first "special technical feature".
2. Claims 18 to 24 are directed to a tine leg and a pivotable foot assembly for carrying a tine. The assembly includes a base plate, a pair of upwardly directed mounting brackets pivotably attached to the tine leg. At least one of the mounting brackets includes an extension projecting beyond the horizontal axis. The assembly has an arm to limit pivotal travel of the base plate in a first direction, spring means between the arm and the base plate, and a limiting member to limit pivotal travel of the base plate in a second direction. It is considered that the tine leg and the pivotable foot assembly as claimed comprise a second "special technical feature".

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU02/00620

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	4400984	BE	886885	CA	1154797	DE	3048891
		DK	5520/80	ES	498172	ES	8201470
		FR	2472426	GB	2066197	IT	1129499
		JP	56103026	NO	803931	SE	7910725
END OF ANNEX							